The Builder.

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SATURDAY, SEPTEMBER 27, 1851.

SOME interesting and important experiments on the strength of cements, &c., were made on the 20th, 22nd, and 23rd inst., at the Great Exhibition, under the supervision of the jury of Class XXVII., when the large beam of hollow bricks and Portland cement, erected in the area at the west end of the building by Messrs. J. B. White and Sons, of Millbank, was broken down. The experiments were watched with great interest by a large number of scientific men and others. Confining ourselves for the present to the works of the firm we have named, we will record some of the experiments which preceded the attack on the beam. The weights used were iron pigs, averaging 100 lbs. each.

The first experiment was on a block of neat Portland cement 4 inches square, suspended at each end, and 16 inches long between the bearings. The weight was applied exactly in the centre. This was broken down by 1,580 lbs., including the weight of the scale: the fracture was perpendicular. The block was four months old.

2. A block of neat Roman cement (Harwich stone), exactly the same size as the last, seven months old, broke down with 380 lbs. This must have been defective, and we may say, as applying throughout, that single experiments on the strength of materials must never be trusted to for general deductions, the most extraordinary variations being often found in specimens prepared under, what may be considered, precisely the same circumstances.

3. A block of neat Sheppy cement, the same size as the last, broke with 980lbs. in the scale.

4. A block of neat Portland cement, six months old, 2 inches thick, and 2¾ inches wide, required 2,280 lbs. to pull it asunder.

5. Two pieces of Portland stone, 6 inches square (each 6 inches high too), cemented together by a thin joint of neat Portland cement (four months old), were suspended. When 3,700lbs. were in the scale attached to the lower stone, the top stone yielded where the iron clippers held it. Afterwards the square holes for the ends of the clippers were made deeper in another part of the stone, and 4,800 lbs. were put into the scale, when the iron hook broke, the joint remaining sound.

The materials here used being Portland stone and Portland cement, it was with difficulty that some of the foreigners present could be made to understand that the latter was not made from the former, and we mention the circumstance as an illustration of the erroneous impressions given by improper appellations. It is the same with Roman cement. A scientific French writer in describing that marvellous piece of construction, the Thames Tunnel, deceived by the name, says that the engineer succeeded here by adopting *the cement of the ancient Romans*, although, as we know very well, the cement in question which really was used had no more to do with the Romans than it had with the Pope.

6. Two pieces of Portland stone, the same size as the last, joined together with Roman cement, five months ago (a thicker joint, by the way, than in the previous case), required 2,780 lbs. (including scale) to separate them,—a much greater weight than was anticipated. The cement left the stone; so that its adhesive power yielded, not its cohesive.

Turning now to the principal example of the series,—the hollow-brick beam,—we annex views of the front and end of it, showing its dimensions and construction, and the mode of applying the weight.

During Saturday the beam was loaded in the central part with 15,000 lbs. weight of pig iron, and in this state it was left until one o'clock on Monday, when it was carefully examined and found quite free from any indication of failure. The loading was then resumed until it was weighted with 40,000 lbs., at which time a deflection of nearly one-eighth of an inch was observed: with 41,600 lbs. two cracks exhibited themselves in the four lower courses, at a short distance right and left of the centre of the beam, and then a crack in the centre of the beam. With 51,600 lbs. the cracks extended through the six lower courses and the deflexion increased to five-sixteenths of an inch; with 62,800 lbs., which it bore for a short time, the beam gradually separated into two parts as nearly equal as possible, the line of fracture being vertical and indiscriminately through bricks and joints as they occurred. In falling, the beam thrust the piers considerably out of an upright.

It will be remembered by many that in 1837 an experimental brick beam was (at the suggestion of Mr. Brunel) built by Messrs Francis and White, at their cement works, Nine Elms, Vauxhall, for the purpose of ascertaining the strength of Roman cement. The beam consisted of hard stock bricks, bonded in the usual way, and bedded and grouted with a mixture in equal portions of the best Roman cement and clean Thames sand, making it completely solid throughout. It consisted of nineteen courses of bricks, the thirteen uppermost courses being two bricks, or 18 inches, in thickness, and the six lower courses two-and-a-half bricks, or 1 foot 10½ inches, in thickness. The sectional area was, therefore, thirteen courses, at 3 inches each, = 39 inches × 18 inches thickness = 702 inches; six courses, at 3 inches each, = 18 inches × 22½ inches thickness = 405 inches, total sectional area 1,107 superficial inches, and in the lower courses were inserted (as we understand) fifteen lengths of hoop-iron, 1½ inch and $\frac{1}{16}$ inch.* The beam was supported at each end, leaving a clear bearing of 21 feet 4 inches, and after it had been built about *three months* it was loaded with 11,200 lbs. of pig iron, placed on a platform, which was suspended at the central part of the beam, which weight was increased at the end of another three months to 24,000 lbs. In this state it was left for twelve months, at the termination of which period it was determined to load it until it broke down, which was effected by increasing the weight to 50,622 lbs.

Messrs. White and Sons had determined, *for the purpose of exhibiting the strength of Portland cement as compared with Roman cement*, to erect a brick beam in all respects similar to the last described (except the substitution of *Portland* for *Roman* cement); but a short time previously to the opening of the Exhibition, it was suggested to them that if they made use of hollow bricks instead of the ordinary solid bricks, it would add much to the interest of the experiment (as experiments upon hollow bricks were much wanted); and in compliance with this suggestion, they erected, a few days before the opening of the Exhibition, *a beam of hollow or tubular bricks, with Portland cement and sand (in equal portions)*, with iron hooping in the lower courses, and generally following, in all respects, the dimensions and form of the beam built with Roman cement at Nine Elms, as far as the use of the hollow bricks would permit. The weight was applied in the central part of a clear bearing of 21 feet 4 inches, in the same manner as to the Roman cement beam. The use of the hollow bricks occasioned some difference in the sectional area, which we have to take into account; but we shall disregard in the present comparison the disadvantages arising from having merely the narrow edges of the tubes to connect with the cement instead of the broad surfaces of ordinary bricks.

The Portland cement beam, as will be seen by the accompanying diagrams, consisted of ten courses, the upper part having three courses on edge, and four flatwise, and the lower part two courses on edge, and one flatwise. The bricks were all laid as stretchers, and the beam consequently consisted of a series of forty tubes (the number of bricks in section throughout), which were open from end to end of the beam. The average size of the bricks was 5¼ inches by 4¼ inches, and, the rims or sides being about ¾ of an inch in thickness, the tubular or hollow parts were each equal to 9 inches super. But with the joints and beds the whole measured in the six upper courses an average of 36 inches × 17.25 inches, = 621 inches; and in the three lower courses an average of 16.5 × 26.6 inches, = 439 inches; making a total area of 1,060 inches: from this deducting the forty vacuities, or hollow parts, of 9 inches each, = 360 inches, we have, as the net sectional area, 700 inches.

By an inspection of the diagram it will be seen that as the vacuities are distributed throughout the whole depth of the beam, they occasion a loss of strength nearly proportionate to their whole extent, varying of course as their distances from the neutral axis.

On the part of Messrs. White it is argued that the depth of the Roman cement beam being 57 inches, and the sectional area 1,107 inches; and the depth of the Portland beam being 52½ inches, and its net area, 700 inches, we shall have 1,107 × 57 = 63,099; and 700 × 52½ = 36,750, as expressions of the relative strength of the two beams, supposing they had been built of the same materials.

The *Roman* cement beam (as before mentioned) was broken down with 50,652 lbs., and since 63,099 : 36,750 :: 50,652 : 29,500, it follows that if the *Portland* cement beam had broken down with 29,500 lbs., the two cements would have exhibited equal strength; but, inasmuch as it took 62,900 lbs. to break down the *Portland* cement beam, the experiment exhibited a superiority of *Portland* cement over

* General Pasley says, in his work "On Limes," five only, p. 162.

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